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Original Article

Changes in Ambulance Calls After Implementation of a Smoke-Free Law and Its Extension to Casinos

Stanton A. Glantz, PhD; Erin Gibbs, BS

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Background—Casinos are often exempted from legislation mandating smoke-free environments, potentially putting employees and patrons at risk for adverse events triggered by secondhand smoke exposure.

Methods and Results—We used an interrupted time series analysis of ambulance calls not originating and originating from casinos in Gilpin County, Colorado, a rural Colorado county with a large casino presence, from January 2000 through December 2012 to determine whether there was a change in ambulance calls originating from casinos when a state smoke-free law was extended to include them. Initial implementation of the smoke-free law (which exempted casinos) was followed by a significant 22.8% drop in ambulance calls (incidence rate ratio, 0.772; 95% confidence interval, 0.685–0.871; $P < 0.001$) from locations other than casinos but no significant change in calls from casinos ($P > 0.9$). The law requiring smoke-free casinos taking effect was followed by a 19.1% (incidence rate ratio, 0.809; 95% confidence interval, 0.724–0.905; $P < 0.001$) drop in ambulance calls from casinos but no change in calls originating outside casinos ($P > 0.1$).

Conclusions—The observation that ambulance calls not coming from casinos dropped when the smoke-free law was initially implemented (excluding casinos) with no change in calls from casinos, followed by a comparable drop in calls originating from casinos (but not calls from elsewhere) when the law was extended to casinos, suggests that the important effects of secondhand smoke exposure occur acutely. These results also suggest that exempting casinos from smoke-free laws means that more people will suffer medical emergencies. (*Circulation*. 2013;128:00-00.)

Key Words: cardiovascular diseases ■ emergency medical services ■ public policy ■ risk factors
■ smoking ■ tobacco smoke pollution ■ utilization

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There is strong and consistent scientific evidence that there are drops in hospital admissions for acute myocardial infarction, other cardiac events, stroke, asthma, and other pulmonary events after implementation of smoke-free laws,^{1,2} with stronger laws being associated with bigger effects.² This benefit is stable over time,² still persistent 4 years after implementation of the law.³ Some of this observed drop is attributable to fewer events being triggered acutely by exposure to secondhand smoke; some is attributable to longer-term effects of reduced exposure; and some is attributable to some smokers quitting as a result of these laws. On July 1, 2006, the state of Colorado implemented a state law that made all workplaces, public places, restaurants, and bars smoke-free, but casinos were exempted. The law was extended to casinos on January 1, 2008. Both patrons and employees in casinos continued to be subjected to acute secondhand smoke exposure when other places were smoke-free. Therefore, examining differences in ambulance calls originating from casinos before and after the casinos were made smoke-free could provide information on the importance of acute changes in secondhand smoke as causes of medical emergencies. This study uses interrupted time series analysis⁴ to examine whether these policy changes were

followed by changes in ambulance calls originating from the general public and from casinos.

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Methods

Data were obtained on the number and origin (not casino or casino) of ambulance calls for each month from January 2000 through December 2012 for Gilpin County, Colorado, routinely collected by the Gilpin Ambulance Authority, a governmental nonprofit agency that handles all ambulance calls in the county. The Gilpin Ambulance Authority's response area is 150 square miles 30 miles west of Denver in Colorado's high country. Gilpin County is a major tourist destination; the 2009 Census showed a resident population of 5604, but the visitor population can exceed 40 000 at any given time as a result of people working at, staying at, or visiting local casinos and hotels in Black Hawk and Central City. The gaming district occupies 2 to 3 square miles of Gilpin County and in March 2013 contained 26 casinos. The Gilpin Ambulance Authority tracks whether calls originated from casinos to qualify to apply for gaming impact grants from the state of Colorado. For purposes of that grant process and this research study, gaming calls are those originating inside or just outside a casino.

There were a total of 16 636 ambulance calls during the study period, 6531 not from casinos and 10 105 from casinos.

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The data were analyzed by the use of multiple linear and negative binomial regressions with the number of ambulance calls each month originating from places other than casinos and from casinos as the dependent variables (in separate analyses). The independent variables were time (to allow for an underlying secular trend), dummy variables to indicate whether the state smoke-free law was in effect (1 beginning on July 1, 2006; 0 before then), whether the smoke-free casino provision was in effect (1 beginning January 1, 2008; 0 before that), and dummy variables for month to allow for seasonal variation. In addition, because the law was changed to extend casino hours from 8 AM to 2:30 AM to 24 hours a day effective July 1, 2009, we included a dummy variable (1 after July 1, 2009; 0 before that) to account for this policy change to allow for the possibility that longer casino hours would be accompanied by more ambulance calls from casinos.

Correlograms of the residuals revealed mild but statistically significant autocorrelations in the residuals for the fit to the data from the casinos (first lag autocorrelation, 0.18; second, 0.54; and third, 0.11, with $P=0.022$, $P=0.058$, and $P=0.047$, respectively, for linear regression; results were similar for the negative binomial regression), so we added the lagged (1 month) independent variable to the regression models. Adding the lagged independent variable reduced all the autocorrelations to nearly zero and nowhere near significant (all $P>0.4$). The noncasino data did not exhibit autocorrelated residuals, but we included the lagged independent variable in that model for consistency. Adding the lagged independent variables improved residual properties but did not substantially affect the estimates.

Calculations were done with Stata 12.1.

Results

Initial implementation of the smoke-free law was followed by a significant 22.8% drop in ambulance calls (incidence rate ratio, 0.772; 95% confidence interval, 0.685–0.871; $P<0.001$) from locations other than casinos but no significant change in calls from casinos ($P>0.9$; Table and Figure). The law requiring smoke-free casinos taking effect was followed by a 19.1% (incidence rate ratio, 0.809; 95% confidence interval, 0.724–0.905; $P<0.001$) drop in ambulance calls from casinos but no change in calls originating outside casinos ($P>0.1$). When hours were extended, there was a 33.1% (incidence rate ratio, 1.331; 95% confidence interval, 1.190–1.487) increase in calls from casinos but no significant change in calls from noncasino locations ($P>0.3$).

These drops correspond to reductions of about 175 calls per year from locations other than casinos and 180 calls per year from casinos.

Discussion

Although there is a well-developed literature showing that hospital admissions drop after implementation of smoke-free laws,^{1,2} this is the first study to show an effect on ambulance calls. The fact that there were changes in ambulance calls originating from casinos after, but not before, the smoke-free law was extended to casinos suggests that a substantial part of the effect of these laws is to reduce the acute effects of secondhand smoke exposure and the acute effects of smokers no longer smoking while in the casinos. This result is consistent with human experimental studies showing rapid (within 30 minutes) effects of secondhand smoke exposure on vascular and endothelial function.^{5,6} The finding that the magnitudes of the reductions in ambulance calls were similar in the general community and casinos (22.8% and 19.1%) when these 2 venues were made smoke-free also points to an effect of acute exposure to secondhand smoke. These changes are also similar to observed reductions in hospitalizations for acute myocardial infarction, asthma, stroke, and other problems that occur after implementation of strong smoke-free laws.²

The observation that ambulance calls from casinos, but not elsewhere, increased when casino hours were increased to 24 hours a day is also evidence that the changes after implementation of the smoke-free law observed in casinos were specific to casinos. These results suggest that the important effects of secondhand smoke exposure occur acutely.

Limitations

We do not have access to data on the outcomes of the ambulance calls or detailed information about the patients, including their smoking status, so it is not possible to differentiate events possibly related to smoking or secondhand smoke (eg, cardiovascular, respiratory) from events not likely to be related. We do not explicitly consider any changes that might occur in the populations at risk, including population growth or changes in the age distribution over the time we analyzed (2000–2012) in Gilpin County or changes in the number of casinos and patrons. We did, however, include a secular trend in the analysis, so it is not necessary to assume that the county population or number of casino attendees remains in steady state throughout the period of the study.

Table. Ambulance Calls per Month

	Not Casinos	P Value	Casinos	P Value
Number of calls				
Year	1.5 (0.6 to 2.4)	0.002	−0.3 (−1.4 to 0.8)	0.581
Smoke-free law	−10.9 (−16.3 to −5.5)	<0.001	−0.4 (−6.7 to 5.9)	0.910
Casinos added	−4.1 (−9.8 to 1.6)	0.158	−11.4 (−18.7 to −4.2)	0.002
Hours extended	2.1 (−3.4 to 7.5)	0.454	16.4 (9.1 to 23.7)	<0.001
Incidence rate ratio (negative binomial regression)				
Year	1.035 (1.014 to 1.056)	0.001	0.996 (0.981 to 1.011)	0.574
Smoke-free law	0.772 (0.685 to 0.871)	<0.001	0.994 (0.908 to 1.088)	0.900
Casinos added	0.905 (0.793 to 1.032)	0.137	0.809 (0.724 to 0.905)	<0.001
Hours extended	1.059 (0.934 to 1.200)	0.370	1.331 (1.190 to 1.487)	<0.001

Coefficients for monthly seasonal variables not shown. Values in parentheses are 95% confidence intervals. The fits for the multiple linear regressions for number of calls for both the noncasino and casino data were highly significant ($P<0.001$ in both cases); R^2 for the number of regressions was 0.39 and 0.27, respectively.

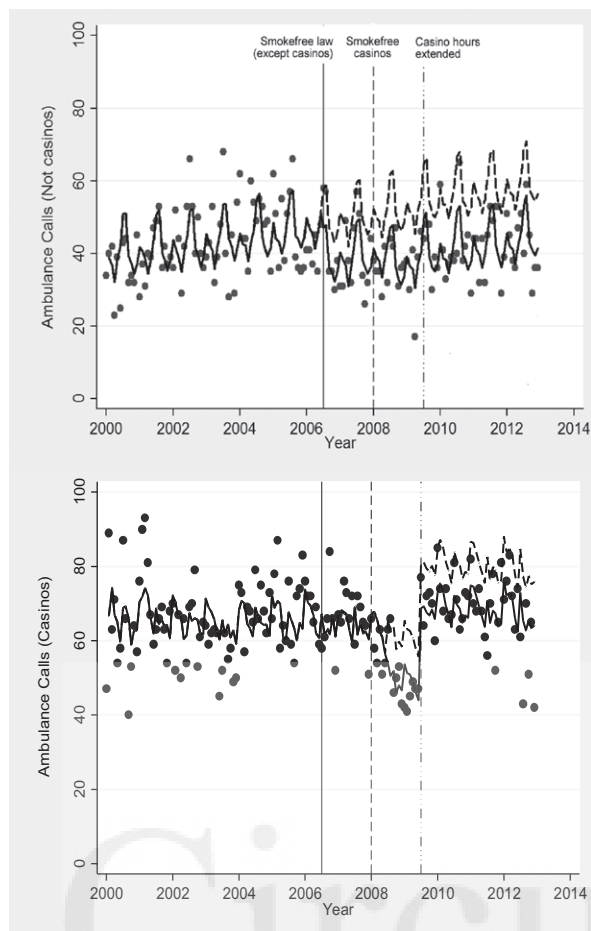


Figure. The number of ambulance calls per month originating from places other than casinos (**top**) dropped significantly when Colorado's smoke-free law took effect everywhere but casinos, but calls from casinos did not (**bottom**). Conversely, there was a drop in calls originating from casinos (**bottom**) when the law was extended to include them but not from calls not originating from casinos (**top**). Ambulance calls from casinos increased (**bottom**) when hours were increased to 24 hours a day but not calls originating elsewhere (**top**). Solid lines on the plots are the predicted number of calls per month from the linear regression; the fits for the negative binomial regressions are the same to within the width of the line. Dots are the number of ambulance calls each month. Dashed lines on the plots are the predicted numbers of ambulance calls had there been no smoking restrictions (ie, the counterfactual keeping law and casino dummies set to 0 and using the other coefficients estimated from all the data). The ups and downs in the regression lines represent seasonal (monthly) variation in the number of calls.

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Conclusions

These results suggest that exempting casinos from smoke-free laws means that more people will suffer medical emergencies as a result. As of April 5, 2013, only 19 states plus Puerto Rico had laws making all state-regulated gambling smoke-free.⁷ In addition, although some tribal casinos are smoke-free, most are not. Our results suggest that applying smoke-free laws to casinos not only would prevent medical emergencies but also would reduce costs to the state, which may incentivize the passing of smoke-free casino laws.

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Disclosures

None.

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CLINICAL PERSPECTIVE

Casinos are often exempted from legislation mandating smoke-free environments, potentially putting employees and patrons at risk for adverse events triggered by secondhand smoke exposure. We found that ambulance calls originating from everywhere but casinos dropped by $\approx 20\%$ when Colorado implemented a smoke-free law that applied everywhere but casinos. Two years later, when the law was expanded to casinos, ambulance calls from casinos dropped by $\approx 20\%$. These results have important implications for both clinicians and policy makers because they show big, fast effects of eliminating secondhand smoke. Clinicians should advise their patients, especially patients at risk of a cardiac or vascular event, to stay away from smoky environments such as casinos. Policy makers (including state lawmakers and Native American tribal leaders) should see that all environments, including casinos, are smoke-free. Failure to do so is sending a substantial number of people to the emergency room.